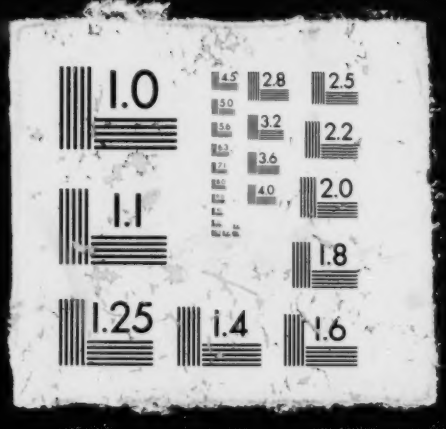
1 OF 1
PB83
182857



PB83-182857

Regional MOBILE2 Estimates

Energy and Environmental Analysis, Inc.
Arlington, VA

Prepared for

Environmental Protection Agency
Ann Arbor, MI

Nov 80

U.S. Department of Commerce
National Technical Information Service
NTIS

PB83-182857

REGIONAL MOBILE2

VARIABLE ESTIMATES

EPA Contract No. 68-03-2888

Prepared for:

TEST AND EVALUATION BRANCH
EMISSION CONTROL TECHNOLOGY DIVISION
OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL
OFFICE OF AIR, NOISE AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN

Prepared by:

ENERGY AND ENVIRONMENTAL ANALYSIS, INC.
1111 North 19th Street
Arlington, Virginia 22209

November 1980

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completing)*		
1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB83 182857
4. TITLE AND SUBTITLE Regional MOBILE2 Variable Estimates.		5. REPORT DATE November 1980 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Energy and Environmental Analysis, Inc. 1111North 19th Street Arlington, VA		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS United States Environmental Protection Agency Office of Mobile Source Air Pollution Control Test and Evaluation Branch Ann Arbor, MI 48105		13. TYPE OF REPORT AND PERIOD COVERED Technical 14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

The purpose of this report is to develop regional estimates of 12 MOBILE2 input variables for use in the MOBILE2 computer program and its supporting documentation. The 12 variables are: mileage accumulation by age, vehicle registrations by age, average trips/day, vehicles miles, total vehicle miles traveled fractions, fraction of vehicles with air conditioning, air conditioning usage, average temperatures, average humidity levels, average percent vehicle miles traveled in cold/hot starts for catalysts and non-catalysts vehicles, fraction of trips with extra load or trailer towing and speed.

The regions discussed in this report are low-altitude non-California, high-altitude non-California and California. Data for California is presented separately from that of other 49 states because the motor vehicle emission standards in the state of California differ from the Federal standards. Therefore, MOBILE2 includes a separate set of emission factor assumptions for California.

17. KEY WORDS AND DOCUMENT ANALYSIS			
a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Air Quality Computer Programming Emission Factors Exhaust Emissions Mathematical Models Motor Vehicles	Mobile Source Emissions model	MOBILE2 Computer Program Regulations State	
18. DISTRIBUTION STATEMENT Release Unlimited		19. SECURITY CLASS *(This Report)* unclassified 20. SECURITY CLASS *(This page)* unclassified	21. NO. OF PAGES 76 22. PRICE

EPA Form 2220-1 (9-73)

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1-1
2.	MILEAGE ACCUMULATION BY AGE	2-1
3.	VEHICLE REGISTRATIONS BY AGE	3-1
4.	AVERAGE TRIPS PER DAY	4-1
5.	VEHICLE MILES PER DAY	5-1
6.	VEHICLE MILES TRAVELED	6-1
7.	FRACTION OF VEHICLES WITH AIR CONDITIONING	7-1
8.	AMBIENT CONDITIONS	8-1
9.	VMT PERCENTAGE IN HOT/COLD STARTS	9-1
10.	EXTRA LOAD AND TRAILER TOWING TRIPS	10-1
11.	SPEED BY ROAD TYPE	11-1

1. INTRODUCTION

The purpose of this report is to describe work performed by EEA, Inc. for Task Order No. 6 of EPA Contract No. 68-03-2888. The objective of this task order was to develop regional estimates of 12 MOBILE2 input variables for use in the MOBILE2 computer program and its supporting documentation. The regions discussed in this report are low altitude non-California, high altitude non-California and California. Data for California are presented separately from that of the other 49 States because the motor vehicle emission standards in the State of California differ from the Federal standards. Therefore, MOBILE2 includes a separate set of emission factor assumptions for California. High altitude areas are defined as counties located substantially above 4,000 feet in elevation. A list of high altitude counties is shown in Table 1-1. Travel characteristics in high-altitude counties are analyzed separately because vehicle emissions change at high altitudes due to the change in atmospheric pressure. The values of the 12 MOBILE2 variables specific to high altitude areas should be used along with MOBILE2 emission factors for high altitude areas to estimate emissions.

Because the region "low altitude non-California" comprises most of the country, estimates for the 12 MOBILE2 variables for this area are essentially the same as nationwide estimates. National MOBILE2 variable estimates were presented in the report for Task Order No. 5 of this contract. However, they are presented again here for completeness.

In most cases, the estimates included in this report reflect data inclusive of both urban and rural areas. Where only urban data were available for making regional estimates, this is specifically noted in the report.

1.1 REPORT ORGANIZATION

Table 1-2 shows the MOBILE2 input variables and vehicle types discussed in this report. The vehicle type abbreviations shown at the bottom of the table are those used throughout the report. The report is organized so that estimation techniques for each variable are presented in separate sections. The only exception to this is that variables 7-9 are combined in one section labeled "Ambient Conditions." Within each section, estimation techniques are presented separately for each vehicle type.

1.2 DATA SOURCES

The information presented in this report for the State of California was taken largely from an Air Resources Board report entitled Procedure and Basis for Estimating On-Road Motor Vehicle Emissions (CARB, 1980). This report was prepared as part of the documentation process for the data the CARB used to estimate present and future motor vehicle emissions in California as of August 1979. It references numerous previous studies to support the data used.

In order to produce estimates for the 12 MOBILE2 variables for high-altitude areas, a number of State and local agencies were contacted for information. As of this writing, not all of the promised material has been received. However, agencies and the information to be provided by that agency are listed below by State:

- Arizona

  Bureau of Air Quality Control

  Vehicular Emissions Inspection Division

  - Average trips per day

State Registry of Motor Vehicles

- Registrations by county

- Colorado

  State Air Pollution Control Division

  - Total VMT fractions
  - Vehicle miles per day
  - Average trips per day

  Registry of Motor Vehicles

  - Mileage accumulation by age

  Denver Tri-County District Transportation Department

  - Average trips per day
  - Mileage accumulation by age

  Denver City - County Air Pollution Control Section

  - Mileage accumulation by age
  - Average trips per day

- Montana

  Montana Air Quality Bureau

  State Department of Transportation

  - Mileage accumulation by age

- New Mexico

  New Mexico Highway Authority

  - Average trips per day
  - Auto occupancy

  Santa Fe Registry of Motor Vehicles

  - Mileage accumulation by age

TABLE 1-1

HIGH ALTITUDE COUNTIES
COUNTIES LOCATED SUBSTANTIALLY ABOVE 1,219 METERS
(4,000 FEET) IN ELEVATION

ARIZONA

Apache	Navajo

COLORADO

Adams	Dolores	Jefferson	Park
Alamosa	Douglas	Lake	Pitkin
Arapahoe	Eagle	La Plata	Pueblo
Archuleta	Elbert	Larimer	Rio Blanco
Boulder	El Paso	Las Animas	Rio Grande
Chaffee	Fremont	Lincoln	Routt
Clear Creek	Garfield	Mesa	Saguache
Conejos	Gilpin	Mineral	San Juan
Costilla	Grand	Moffat	San Miguel
Crowley	Gunnison	Montezuma	Summit
Custer	Hinsdale	Montrose	Teller
Delta	Huerfano	Morgan	Washington
Denver	Jackson	Ouray	Weld

IDAHO

Bannock	Butte	Custer	Minidoka
Bear Lake	Camas	Franklin	Oneida
Bingham	Caribou	Fremont	Power
Blaine	Cassia	Jefferson	Teton
Bonneville	Clark	Madison	Valley

MONTANA

Beaverhead	Gallatin	Madison	Park
Deer Lodge	Jefferson	Meagher	Silver Bow

NEBRASKA

Banner	Kimball	Sioux

TABLE 1-1 (Continued)

HIGH ALTITUDE COUNTIES
COUNTIES LOCATED SUBSTANTIALLY ABOVE 1,219 METERS
(4,000 FEET) IN ELEVATION

NEVADA

Carson City	Esmeralda	Lander	Storey
Douglas	Eureka	Lyon	White Pine
Elko	Humboldt	Mineral	

NEW MEXICO

Bernalillo	Guadalupe	Mora	Sierra
Catron	Harding	Rio Arriba	Socorro
Colfax	Lincoln	Sandoval	Taos
Curry	Los Alamos	San Juan	Torrance
De Baca	Luna	San Miguel	Union
Grant	McKinley	Sante Fe	Valencia

OREGON

Lake

UTAH

Beaver	Emery	Piute	Tooele
Box Elder	Grand	Rich	Uintah
Cache	Iron	Salt Lake	Utah
Carbon	Juab	San Juan	Wasatch
Daggett	Kane	Sanpete	Wayne
Davis	Millard	Sevier	Weber
Duchesne	Morgan	Summit	

WYOMING

Albany	Hot Springs	Niobrara	Sweetwater
Carbon	Johnson	Park	Teton
Converse	Laramie	Platte	Uinta
Fremont	Lincoln	Sublette	Weston
Goshen	Natrona		

TABLE 1-2

MOBILE2 INPUT VARIABLES

Variables	Vehicle Type*
1. Mileage accumulation by age	All
2. Vehicle registrations by age	All
3. Average trips/day	All
4. Vehicle miles/day	All
5. Total VMT fractions	All
6. Fraction of vehicles with air conditioning by model year	All except MC, HDGV, and HDDV
7. Air conditioning usage from ambient condition variables	**
8. Average temperature	**
9. Average humidity levels (grains of water/lb of dry air)	**
10. Average percent VMT in cold/hot starts for catalyst and non-catalyst vehicles	All
11. Fraction of trips/day with either extra load or trailer towing	All except MC, HDGV, and HDDV
12. Speed	All

---

* LDGV: Light-Duty Gasoline-Powered Vehicles
LDDV: Light-Duty Diesel-Powered Vehicles
LDGT1: Light-Duty Gasoline-Powered Trucks (<6001 lbs GVW)
LDGT2: Light-Duty Gasoline-Powered Trucks (>6000 lbs and <8501 lbs GVW)
LDDT: Light-Duty Diesel-Powered Trucks (<8501 lbs GVW)
HDGV: Heavy-Duty Gasoline-Powered Vehicles (>8500 lbs GVW)
HDDV: Heavy-Duty Diesel-Powered Vehicles (>8500 lbs GVW)
MC: Motorcycles

**Independent of vehicle type

2. MILEAGE ACCUMULATION BY AGE

No mileage accumulation by age data are available specific to low or high-altitude areas or California. Therefore, national estimates should be used for all MOBILE2 runs. The national mileage accumulation by age estimates are shown in Tables 2-1 through 2-3.

TABLE 2-1

ESTIMATED ANNUAL MILES TRAVELED AND
MILEAGE ACCUMULATION BY AGE
FOR LIGHT-DUTY VEHICLES

NATIONAL AVERAGES

Age	Estimated Annual Miles	Accumulated Miles
1	14,436	14,436
2	13,903	28,339
3	13,371	41,710
4	12,838	54,548
5	12,306	66,854
6	11,773	78,627
7	11,240	89,867
8	10,708	100,575
9	10,176	110,751
10	9,643	120,394
11	9,110	129,504
12	8,577	138,081
13	8,045	146,126
14	7,513	153,639
15	6,980	160,619
16	6,447	167,066
17	5,927	172,993
18	5,382	178,375
19	4,850	183,225
20	4,317	187,542

Source: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1980.

TABLE 2-2

MILEAGE ACCUMULATION BY AGE FOR TRUCK CATEGORIES

NATIONAL AVERAGES

Vehicle Age	LDGT1	LDGT2	HDGV	LDDT	HDDV
1	15,610	15,800	20,980	15,705	70,418
2	14,049	14,220	18,882	15,077	66,897
3	12,488	12,640	17,204	14,605	60,560
4	11,239	11,376	15,525	13,978	54,221
5	10,147	10,270	14,057	13,035	47,885
6	9,366	9,480	12,587	12,093	43,659
7	8,585	8,690	11,329	10,993	39,434
8	7,961	8,058	10,280	9,738	36,618
9	7,493	7,584	9,441	9,266	34,504
10	7,025	7,110	8,602	7,381	33,096
11	6,556	6,636	7,973	6,753	32,392
12	6,244	6,320	7,343	6,125	31,689
13	5,932	6,004	6,713	5,491	30,953
14	5,463	5,510	6,294	5,031	29,606
15	5,151	5,234	5,875	4,555	27,463
16	4,996	5,056	5,454	4,240	24,646
17	4,683	4,740	5,245	3,769	20,422
18	4,370	4,424	5,036	3,141	17,604
19	4,371	4,424	5,034	3,141	17,605
20	4,371	4,424	5,034	3,141	17,605

Source: Jambekar and Johnson, 1977.

TABLE 2-3

NATIONAL AVERAGE MILES PER YEAR BY AGE AND MILEAGE ACCUMULATION BY AGE FOR MOTORCYCLES

Age	Average Miles* Per Year	Average Mileage Accumulation
1	4067	4067
2	2845	6912
3	2072	8984
4	1569	10553
5	1180	11733
6	777	12510
7	630	13140
8	387	13527
9	243	13770
10	162	13932
11	162	14094
12	162	14256
13	162	14418

Mean number of months per year 7
Median number of months per year 7

---

* Weighted by the mix of on-road and dual purpose motorcycles registered in 1978.

Source: Personal Communication with Pam Amette, Motorcycle Industry Council, Inc., and the 1979 Motorcycle Statistical Annual

3. VEHICLE REGISTRATIONS BY AGE

Estimates of vehicle registrations by age for the eight MOBILE2 vehicle type categories are presented separately in this section for low altitude regions, high altitude regions, and the State of California. Table 3-1 summarizes registrations by age by vehicle type information for low altitude regions. It is assumed here that national estimates of registrations by age apply to low altitude regions.

Table 3-2 summarizes registrations by age by vehicle type information as reported by the State of California. Because the estimates in this table are not for the same time period assumed in MOBILE2, they must be adjusted to represent a model year mix rather than an age mix. The adjusted numbers are shown in Table 3-3. The Table 3-3 registration fractions were calculated using the following equation:

$$F_n = (.75)R_n + (.25)R_{n-1} \qquad (3\text{-}1)$$

where: F_n = Model year mix registration fraction in year n

R_n = Age registration fraction in year n (from Table 3-2)

The 0.75 and 0.25 factors are used because it is assumed that new model year sales begin on October 1st of each year.

Table 3-3 does not include registrations by age estimates for LDDV's or LDDT's. Therefore, the registration fractions in Table 3-1 for these categories can be assumed to apply for the State of California as well.

Estimates of vehicle registrations by age for high altitude regions were calculated from R.L. Polk data for the years 1969-1978. The R.L. Polk

data represent new vehicle registrations of passenger cars and trucks (eight categories of trucks) for each month during this time period. Data for the 10 States with high altitude counties are shown in Table 3-4.

Because the R.L. Polk data represent new vehicle registrations in each month, and do not track the registrations by model year, these data are not in the best possible form for use in MOBILE2. However, in producing registration estimates, these data were used as if they represented registrations by model years. This assumption was necessary in order to apply information collected under previous task orders of this contract and to make the R.L. Polk data compatible with MOBILE2. For instance, scrappage rates had to be applied to the R.L. Polk data to estimate the number of vehicles of each model year still in operation in the base calendar year.

All vehicle registration estimates provided in this section are based on an October-September year. Therefore, registrations listed for calendar year 1978 are for vehicles registered between October 1, 1977 and September 30, 1978. The R.L. Polk data for light-duty vehicles were presented on a monthly basis and cumulatively for a January-December year. Therefore, the number of vehicles registered as of October 1 of each year was calculated as follows:

	Registrations	Jan - Sept	Current Year
+	Registrations	Jan - Dec	Preceding Year
-	Registrations	Jan - Sept	Preceding Year
=	Registrations	Oct - Sept	

This calculation procedure permitted the use of cumulative rather than monthly totals. Hence, the number of calculations was reduced.

For the high-altitude States, data on 1975 county and state populations were used to determine the percentage of the population in each state residing in high-altitude counties. These percentages are shown in Table 3-5. This number was used as a surrogate for vehicle population. Thus, the number of vehicles registered in high altitude counties in each State was estimated by multiplying the number of vehicles registered in the state by the high-altitude population percentage for that state.

With R.L. Polk data for high altitude states only available for calendar years 1970-1978 for light-duty vehicles, and for 1970-1977 for trucks, additional assumptions were needed to estimate a 20 year registration distribution. The methodology is the same for each vehicle category, except for trucks, where a 1978 value had to be determined so that all registration by age estimates had a common base year. The 1978 registration estimates for the MOBILE2 truck categories were made using R.L. Polk data reported in the Automotive News 1980 Market Data Book Issue. These 1978 truck registration data are shown in Table 3-6. To estimate the number of trucks registered only in the high altitude regions of the states in Table 3-6, the population percentages in Table 3-5 are applied. The high altitude region totals are estimated to be:

Weight Class	1978 High-Altitude Region Registrations
0-6000 lbs.	43,794
6001-8500 lbs.	74,662
>8500 lbs.	33,606

The numbers in Table 3-4 are not sufficient to produce a 20 year distribution for high altitude region vehicle registrations. Therefore, the number of registered vehicles for years 10-20 are estimated using nationwide sales and registration estimates for each vehicle category from Section 3 of National MOBILE2 Variable Estimates, 1980. The specific

numbers used to apportion the nationwide sales or registrations for years 10-20 to the high altitude regions are shown at the bottom of Tables 3-7 through 3-13 for each vehicle type.

R.L. Polk presents monthly new vehicle registration data for trucks classified into eight gross vehicle weight classes. Except for the 6001-10,000 lb. GVW category, the Polk data match the categories needed for MOBILE2. It is assumed here that 13 percent of the 0-10,000 lb. GVW trucks are 8500-10,000 lbs., and the Polk data were apportioned accordingly. Because diesel and gasoline-powered trucks were not identified separately in the Polk statistics, it was assumed that 62% of all trucks greater than 8500 lbs. GVW are gasoline-powered. This estimate is based on the fleetwide percentage for the sample of trucks in the 1977 Census of Transportation Truck Inventory and Use Survey.

After determining the number of new vehicle registrations for each year, it was necessary to apply nationwide scrappage rates to estimate the percentage of new registrations remaining in service in 1978.

Table 3-15 summarizes the registration by age information for high altitude regions for all vehicle types. These values can be compared with the low altitude region estimates in Table 3-1 and the State of California estimates in Table 3-3 to note the differences in the registration fractions.

Table 3-1

LOW-ALTITUDE REGIONS
REGISTRATIONS BY AGE BY VEHICLE TYPE (1978)

Model Year Mix	LDGV	LDDV	LDGT1	LDDT	LDGT2	HDGV	HDDV	MC
1	.072	.413	.096	1.000	.245	.128	.177	.133
2	.101	.321	.095		.207	.114	.142	.145
3	.092	.176	.086		.155	.097	.085	.138
4	.071	.090	.061		.097	.074	.054	.116
5	.092		.091		.057	.086	.098	.123
6	.103		.099		.056	.088	.093	.114
7	.089		.076		.039	.071	.072	.069
8	.071		.060		.030	.053	.051	.044
9	.066		.044		.023	.041	.042	.024
10	.059		.048		.020	.044	.042	.009
11	.048		.046		.017	.040	.031	.085
12	.035		.033		.011	.031	.023	
13	.030		.035		.010	.030	.025	
14	.023		.033		.008	.026	.019	
15	.015		.026		.005	.021	.013	
16	.010		.021		.005	.018	.009	
17	.006		.015		.004	.013	.007	
18	.002		.011		.003	.009	.004	
19	.002		.010		.003	.008	.004	
20+	.014		.012		.004	.010	.007	

SOURCE: Taken from Section 3 of National MOBILE 2 Variable Estimates, 1980.

TABLE 3-2

STATE OF CALIFORNIA
REGISTRATIONS BY AGE BY VEHICLE TYPE*

Vehicle Age	LDGV	LDGT1	LDGT2	HDGV	HDDV	MC
0	.0038	.0039	.0039	0	0	0
1	.0647	.0654	.0654	.0567	.0504	.14
2	.0986	.1082	.1082	.0875	.084	.14
3	.097	.095	.095	.079	.075	.14
4	.0945	.0835	.0835	.0726	.069	.13
5	.092	.0745	.0745	.0676	.0663	.12
6	.0875	.068	.068	.0635	.065	.1
7	.082	.0625	.0625	.0592	.064	.06
8	.0745	.057	.057	.0549	.0605	.05
9	.0665	.0515	.0515	.0506	.055	.04
10	.0565	.046	.046	.0463	.0495	.03
11	.046	.0405	.0405	.042	.044	.02
12	.0345	.035	.035	.0377	.0385	.015
13	.0255	.0295	.0295	.0334	.033	.01
14	.0185	.025	.025	.0298	.0295	.005
15	.014	.0225	.0225	.0278	.0276	0
16	.0105	.02	.02	.0258	.0259	0
17	.0079	.0175	.0175	.0238	.0242	0
18	.006	.015	.015	.0218	.0225	0
19	.004	.0129	.0129	.0198	.0208	0
20+	.0235	.0666	.0666	.1002	.0953	0

SOURCE: State of California Air Resources Board, 1980.

*Estimates are as of January 1 of each year. For LDGV's averages from the 1968-1975 Polk reports were used to produce a distribution curve for registrations vs. age. For LDGT1 and LDGT2, the Polk statistics for 1970-1975 were used to produce the above distribution. For HDGV's only registrations of General Motors trucks were used. It was assumed that GM would be most representative of HDGV trends. Data from the following manufacturers were assumed to represent use trends for HDDV's: Diamond-Reo, Kenworth, Mack, Peterbilt, and White.

Table 3-3

STATE OF CALIFORNIA
REGISTRATIONS BY MODEL YEAR MIX BY VEHICLE TYPE*

Model Year Mix	LDGV	LDGT1	LDGT2	HDGV	HDDV	MC
1	.052	.053	.053	.043	.038	.105
2	.090	.098	.098	.080	.076	.140
3	.097	.098	.098	.081	.077	.140
4	.095	.086	.086	.074	.071	.133
5	.093	.077	.077	.069	.067	.123
6	.089	.070	.070	.065	.065	.105
7	.083	.064	.064	.060	.064	.070
8	.076	.058	.058	.056	.061	.053
9	.069	.053	.053	.052	.056	.043
10	.059	.047	.047	.047	.051	.033
11	.049	.042	.042	.043	.045	.023
12	.037	.036	.036	.039	.040	.016
13	.028	.031	.031	.034	.034	.011
14	.020	.026	.026	.030	.030	.005
15	.015	.023	.023	.028	.028	0
16	.011	.021	.021	.026	.026	0
17	.009	.018	.018	.024	.025	0
18	.006	.016	.016	.022	.023	0
19	.005	.013	.013	.020	.021	0
20+	.017	.070	.070	.107	.102	0

* The numbers in this table are those in Table 3-2 adjusted to a model year basis rather than on an age basis.

Table 3-4

HIGH-ALTITUDE REGIONS
ESTIMATED NEW VEHICLE REGISTRATIONS FROM
R. L. POLK AND CO. DATA*

Year	Light-Duty Vehicles	Light-Duty Trucks 0-6000 lb. GVW	Light-Duty Trucks 6000-8500 lb. GVW	Heavy-Duty Trucks >8500 lb. GVW
1978	254,862			
1977	243,312	35,391	64,123	25,549
1976	219,721	43,463	51,051	25,068
1975	180,656	42,818	26,933	20,628
1974	206,479	63,167	20,465	24,672
1973	252,111	70,957	24,124	27,244
1972	230,426	58,256	18,310	22,351
1971	183,564	39,127	13,164	17,769
1970	181,812	40,358	12,857	15,169
	1,952,943	393,537	231,027	178,450

*An October 1 - September 30 year was used to summarize the R.L. Polk registration data.

TABLE 3-5

STATES WITH COUNTIES LOCATED SUBSTANTIALLY
ABOVE 4000 FT. IN ELEVATION

State	Percentage of 1975 Population In High-Altitude Counties*
Arizona	2.68%
Colorado	96.11
Idaho	34.11
Montana	17.53
Nebraska	0.58
Nevada	15.57
New Mexico	74.14
Oregon	2.37
Utah	98.22
Wyoming	84.82

*SOURCE: Bureau of the Census 1975 population estimates.

Table 3-6

HIGH-ALTITUDE REGIONS
1978 NEW TRUCK REGISTRATIONS BY STATE

States	New Truck* Registrations	Estimated** Registrations <6000 lbs. GVW	Estimated** Registrations 6000-8500 lbs. GVW	Estimated** Registrations >8500 lbs. GVW
Arizona	53,045	15,277	26,045	11,733
Colorado	59,330	17,087	29,131	13,112
Idaho	25,506	7,346	12,523	5,637
Montana	26,228	7,554	12,878	5,796
Nebraska	37,214	10,718	18,272	8,224
Nevada	21,208	6,108	10,413	4,687
New Mexico	34,550	9,950	16,964	7,636
Oregon	68,776	19,807	33,769	15,199
Utah	32,060	9,233	15,741	7,085
Wyoming	21,302	6,135	10,459	4,708
		109,215	186,195	83,817

* Source: Automotive News 1980 Market Data Book Issue.

** For each state, truck registrations were apportioned to the MOBILE 2 truck weight classes using the assumption that the 1978 national percentage of truck registrations by gross vehicle weight (GVW) can be applied to estimate the GVW breakdowns in each state. The 1978 U.S. truck registrations by GVW are as follows:

Wt. Class	Number of Registrations
0-6000 lbs. GVW	1,143,064
6000-10,000 lbs. GVW	2,408,269
>10,000 lbs. GVW	412,007

Using the assumption that 87 percent of trucks 0-10,000 lbs. GVW are 0-8500 lbs. GVW, the percentage of trucks in the MOBILE 2 truck categories are estimated to be:

Wt. Class	Percentage of 1978 Registrations
0-6000 lbs. GVW	28.8
6000-8500 lbs. GVW	49.1
>8500 lbs. GVW	22.1

Table 3-7

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATIONS FOR
LIGHT-DUTY GASOLINE VEHICLES (1978)

Model Year Mix	Estimated New LDV Registrations (From Table 3-4)	Fleet Sales* Fraction for LDGV	Estimated New LDGV Registrations	1-SR**	Estimated LDGV Registrations
1	254,862	.991	252,568	1.000	252,568
2	243,312	.995	242,095	.992	240,158
3	219,721	.997	219,062	.968	212,052
4	180,656	.998	180,295	.951	171,461
5	206,479	1.0	206,479	.925	190,993
6	252,111	1.0	252,111	.884	222,866
7	230,426	1.0	230,426	.824	189,871
8	183,564	1.0	183,564	.750	137,673
9	181,812	1.0	181,812	.656	119,269
					1,736,911

* The estimated fraction of the light-duty vehicle fleet which is gasoline-powered is taken from Murrell et al. (1980).

** From Table 3-3 in the Techniques report.

Table 3-8

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATION FRACTIONS FOR
LIGHT-DUTY GASOLINE VEHICLES (1978)

Model Year Mix	Estimated LDGV Registrations	Registration Fractions
1	252,568	.110
2	240,158	.104
3	212,052	.092
4	171,461	.075
5	190,993	.083
6	222,866	.097
7	189,871	.083
8	137,673	.060
9	119,269	.052
10	136,139	.059
11	109,971	.048
12	80,270	.035
13	69,177	.030
14	52,984	.023
15	34,555	.015
16	22,835	.010
17	12,771	.006
18	5,726	.002
19	4,026	.002
20+	33,302	.014
	2,298,667	

Age 1-9 total LDGV registrations (R. L. Polk) = 1,736,911

Nationwide registrations 1970-1978 = 77,660,225

Table 3-9

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATION FRACTIONS FOR
LIGHT-DUTY DIESEL VEHICLES (1978)

Model Year Mix	Estimated New LDV Registrations	Fleet Sales* Fraction for LDDV	Estimated New LDDV Registrations	1-SR**	Estimated LDDV Registrations	Registration Fractions
1	254,862	.009	2994	1.000	2994	.5778
2	243,312	.005	1217	.992	1207	.2329
3	219,721	.003	659	.968	638	.1231
4	180,656	.002	361	.951	343	.0662
					5182	

* The estimated fraction of the light-duty vehicle fleet which is diesel-powered is taken from Murrell et al. (1980).

** From Table 3-3 in the Techniques report.

Table 3-10

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATION FRACTIONS FOR
LIGHT-DUTY GASOLINE TRUCKS (0-6000 LBS. GVW) (1978)

Model Year Mix	Estimated New LDGT1 Registrations	1-SR <10,000 lbs.	Estimated LDGT1 Registrations	Registration Fractions
1	43,403	1.00	43,403	.085
2	35,391	0.97	34,329	.068
3	43,463	0.93	40,421	.080
4	42,818	0.88	37,680	.074
5	63,167	0.83	52,429	.103
6	70,957	0.78	55,346	.109
7	58,256	.073	42,527	.084
8	39,127	0.68	26,606	.052
9	40,358	0.63	25,426	.050
10	41,941	0.59	24,745	.049
11	42,632	0.55	23,448	.046
12	33,345	0.51	17,006	.033
13	38,159	0.47	17,935	.035
14	39,368	0.43	16,928	.033
15	33,480	0.40	13,392	.026
16	30,502	0.36	10,981	.022
17	24,342	0.32	7,790	.015
18	20,895	0.28	5,851	.012
19	21,306	0.25	5,326	.010
20+	32,216	0.21	6,351	.013
			507,920	

Age 1-9 total new vehicle registrations = 436,940

Nationwide sales 1970-1978 = 10,960,170

Table 3-11

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATION FRACTIONS FOR
LIGHT-DUTY GASOLINE TRUCKS (6000-8500 LBS. GVW) (1978)

Model Year Mix	Estimated New Vehicle Registrations	1-SR <10,000 lbs.	Estimated LDGT2 Registrations	Registration Fractions
1	74,662	1.00	74,662	0.247
2	64,123	0.97	62,199	0.206
3	51,051	0.93	47,477	0.157
4	26,933	0.88	23,701	0.079
5	20,465	0.83	16,986	0.056
6	24,124	0.78	18,817	0.062
7	18,310	0.73	13,366	0.044
8	13,164	0.68	8,952	0.030
9	12,857	0.63	8,100	0.027
10	10,287	0.59	6,069	0.020
11	9,518	0.55	5,235	0.017
12	6,654	0.51	3,394	0.011
13	6,242	0.47	2,934	0.010
14	5,631	0.43	2,421	0.008
15	4,068	0.40	1,627	0.005
16	4,585	0.36	1,651	0.005
17	4,219	0.32	1,350	0.004
18	3,071	0.28	860	0.003
19	3,107	0.25	777	0.003
20+	6,038	0.21	1,192	0.004
			301,770	

Age 1-9 total new vehicle registrations = 305,689

Nationwide Sales 1970-1978 = 5,733,757

Table 3-12

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATION FRACTIONS FOR
HEAVY-DUTY GASOLINE VEHICLES (>8500 LBS. GVW) (1978)

Model Year Mix	Estimated New Vehicle Registrations	1-SR >10,000 lbs.	Estimated HDGV Registrations	Registration Fractions
1	20,836	1.00	20,836	.171
2	15,840	.95	15,048	.124
3	15,542	.88	13,677	.112
4	12,789	.79	10,103	.083
5	15,297	.69	10,555	.087
6	16,891	.61	10,304	.085
7	13,858	.54	7,483	.061
8	11,017	.48	5,288	.043
9	9,405	.43	4,044	.033
10	12,741	.38	4,842	.040
11	12,720	.33	4,198	.035
12	11,214	.29	3,252	.027
13	12,167	.25	3,042	.025
14	12,327	.20	2,465	.020
15	11,096	.17	1,886	.015
16	11,390	.14	1,595	.013
17	10,258	.11	1,128	.009
18	9,325	.08	746	.006
19	10,369	.06	622	.005
20+	11,140	.04	446	.006
	8,191	.03	246	
			121,806	

Age 1-9 total new vehicle registrations = 131,475

Nationwide sales 1970-1978 = 4,483,309

Table 3-13

HIGH-ALTITUDE REGIONS
CALCULATION OF REGISTRATION FRACTIONS FOR
HEAVY-DUTY DIESEL VEHICLES (>8500 LBS. GVW) (1978)

Model Year Mix	Estimated New Vehicle Registrations	1-SR >10,000 lbs.	Estimated HDDV Registrations	Registration Fractions
1	12,770	1.00	12,770	.173
2	9,709	.91	8,835	.120
3	9,526	.84	8,002	.109
4	7,839	.77	6,036	.082
5	9,375	.71	6,656	.090
6	10,353	.64	6,626	.090
7	8,493	.58	4,926	.067
8	6,752	.53	3,579	.049
9	5,764	.48	2,767	.038
10	7,121	.43	3,062	.042
11	5,817	.39	2,269	.031
12	4,923	.35	1,723	.023
13	5,986	.31	1,856	.025
14	5,054	.28	1,415	.019
15	3,951	.24	948	.013
16	3,309	.21	695	.009
17	2,700	.19	513	.007
18	1,753	.16	280	.004
19	1,982	.14	277	.004
20+	2,303	.11	253	.007
	1,609	.09	145	
	1,520	.07	106	
			73,739	

Age 1-9 total new vehicle registrations = 80,581

Nationwide sales 1970-1978 = 1,145,791

TABLE 3-14

HIGH-ALTITUDE REGIONS
MOTORCYCLE REGISTRATIONS BY AGE

Calendar Year	Estimated High-Altitude New MC Registrations*	1-SR	Estimated Registrations in 1978	Percentage of Motorcycles Registered
1978	35,119	1.00	35,119	0.157
1977	38,393	.98	37,625	.168
1976	33,984	.96	32,625	.146
1975	30,638	.90	27,574	.123
1974	38,401	.75	28,801	.129
1973	43,837	.55	24,110	.108
1972	42,595	.37	15,760	.070
1971	42,783	.26	11,124	.050
1970	46,554	.17	7,914	.035
1969	30,882	.10	3,088	.014
			223,740	

*Estimated from Motorcycle Industry Council, Inc. data (1978 and 1979 Statistical Annuals) by State.

Table 3-15

HIGH-ALTITUDE REGIONS
REGISTRATIONS BY AGE BY VEHICLE TYPE (1978)

Model Year Mix	LDGV	LDDV	LDGT1	LDDT	LDGT2	HDGV	HDDV	MC
1	.110	.5778	.085	1.000	.247	.171	.173	.157
2	.104	.2329	.068		.206	.124	.120	.168
3	.092	.1231	.080		.157	.112	.109	.146
4	.075	.0662	.074		.079	.083	.082	.123
5	.083		.103		.056	.087	.090	.129
6	.097		.109		.062	.085	.090	.108
7	.083		.084		.044	.061	.067	.070
8	.060		.052		.030	.043	.049	.050
9	.052		.050		.027	.033	.038	.035
10	.059		.049		.020	.040	.042	.014
11	.048		.046		.017	.035	.031	
12	.035		.033		.011	.027	.023	
13	.030		.035		.010	.025	.025	
14	.023		.033		.008	.020	.019	
15	.015		.026		.005	.015	.013	
16	.010		.022		.005	.013	.009	
17	.006		.015		.004	.009	.007	
18	.002		.012		.003	.006	.004	
19	.002		.010		.003	.005	.004	
20+	.014		.013		.004	.006	.007	

4. AVERAGE TRIPS PER DAY

State of California estimates of trips per day per vehicle are shown in Table 4-1. Light-duty vehicle and light-duty truck estimates are air basin-specific. They were made from traffic data obtained from local transportation agencies in the respective air basins. These estimates assume that travel characteristics of light-duty vehicles and light-duty trucks are similar.

No specific data on trips per day were found for low or high-altitude areas. Therefore, national estimates should be used for low or high-altitude areas in MOBILE2. These are shown in Table 4-2.

TABLE 4-1

STATE OF CALIFORNIA
AVERAGE DAILY TRIPS BY AIR BASIN
AND BY VEHICLE TYPE

Vehicle Category	Air Basin	Number of Trips Per Vehicle Per Day
Light-Duty Vehicles Light-Duty Trucks	Sacramento	4.6
	San Diego	3.5
	S.F. Bay Area	3.64
	South Coast	3.94
	South Central Coast	3.94
	Other Air Basins	3.92
Heavy-Duty Gasoline Vehicles	All Air Basins	9.5
Heavy-Duty Diesel Vehicles	All Air Basins	---
Motorcycles	All Air Basins	0.57

SOURCE: California Air Resources Board, 1980.

TABLE 4-2

LOW ALTITUDE AND HIGH ALTITUDE REGIONS
AVERAGE TRIPS PER DAY PER VEHICLE TYPE*

Vehicle Category	Number of Trips Per Vehicle Per Day
Light-Duty Vehicles Light-Duty Trucks	3.05
Heavy-Duty Gasoline Vehicles	6.88
Heavy-Duty Diesel Vehicles	6.65
Motorcycles	1.35

*From Section 4 of National MOBILE2 Variable Estimates, 1980.

5. VEHICLE MILES PER DAY

State of California estimates of vehicle miles traveled per day per vehicle type are shown in Table 5-1. Average miles traveled per day was calculated by dividing CARB estimates of average annual mileage by 365. CARB estimated annual average mileage for light-duty vehicles from traffic data provided by local transportation and air quality agencies in the major air basins. Average annual mileage of medium-duty vehicles was assumed to be equal to that for light-duty vehicles. Heavy-duty gasoline and diesel vehicle mileage is a registration by age-weighted average of mileage accumulation:

$$\sum_{i=0}^{25} a_i b_i, \text{ where} \qquad (5\text{-}1)$$

a_i = number of vehicles age i in-use

b_i = annual mileage of vehicles of age i

The data used in this calculation was collected in the 1972 Truck Inventory and Use Survey. Annual average mileage for motorcycles was estimated using data from the Gallup Survey of Motorcycle Ownership Usage and Maintenance and traffic surveys.

The calculations made to estimate the average miles driven per day per vehicle type for high-altitude areas are shown in Tables 5-2 through 5-8. The results of these calculations are summarized in Table 5-9. Estimated registrations by vehicle type are from Section 3. Annual mileage accrual

schedules are the national estimates in Section 2. In Table 5-9, all vehicle types are assumed to travel 365 days per year except motorcycles. Motorcycles are assumed to drive 7 months or 210 days per year.

In order to produce vehicle miles per day estimates for the State of California using the same calculation procedure as was used for high altitude regions, estimated California registrations by model year by vehicle type were used along with national annual mileage accrual schedules from Section 2. Tables 5-10 through 5-16 show the calculation of average miles per day by vehicle type for the State of California. The results of these calculations are summarized in Table 5-17.

No specific estimates for miles per day are available for low altitude areas. Therefore, national estimates are recommended for use. These national estimates are shown in Table 5-18.

TABLE 5-1

STATE OF CALIFORNIA
AVERAGE MILES TRAVELED PER DAY BY AIR BASIN
AND BY VEHICLE TYPE

Vehicle Type	Air Basin	Miles/Day
Light-Duty Vehicles and Light-Duty Trucks	Sacramento	26.0
	San Diego	25.2
	Bay Area	24.7
	South Coast	27.4
	South Central Coast	27.4
	All Others	25.8
Heavy-Duty Gasoline Vehicles	All	34.2
Heavy-Duty Diesel Vehicles	All	135
Motorcycles	All	5.5

SOURCE: Calculated from annual average mileage reported by California Air Resources Board, 1980.

TABLE 5-2

HIGH-ALTITUDE REGIONS
LIGHT-DUTY GASOLINE AND DIESEL VEHICLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGV + LDDV Estimated Registrations*	Annual Mileage**	VMT by Year ($\times 10^6$)
1	254,862	14,436	3,679.2
2	243,312	13,903	3,382.8
3	219,721	13,371	2,937.9
4	180,656	12,838	2,319.3
5	190,993	12,306	2,350.4
6	222,866	11,773	2,623.8
7	189,871	11,240	2,134.2
8	137,673	10,708	1,474.2
9	119,269	10,176	1,213.7
10	136,139	9,643	1,312.8
11	109,971	9,110	1,001.8
12	80,270	8,577	688.5
13	69,177	8,045	556.5
14	52,984	7,513	398.1
15	34,555	6,980	241.2
16	22,835	6,447	147.2
17	12,771	5,927	75.7
18	5,726	5,382	30.8
19	4,026	4,850	19.5
20+	33,302	4,317	143.8
	2,298,667		26,731.4

*From Tables 3-8 and 3-9.

**From Table 2-1.

TABLE 5-3

HIGH-ALTITUDE REGIONS
LIGHT-DUTY DIESEL TRUCKS (0-8500 LBS. GVW)
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGT1 + LDDT Estimated Registrations*	Annual Mileage**	VMT by Year ($x10^6$)
1	43,794	15,705	687.78
2	34,329	15,077	517.58
3	40,421	14,605	590.35
4	37,680	13,978	526.69
5	52,429	13,035	683.41
6	55,346	12,093	669.30
7	42,527	10,993	467.50
8	26,606	9,738	259.09
9	25,426	9,266	235.60
10	24,745	7,381	182.64
11	23,448	6,753	158.34
12	17,006	6,125	104.16
13	17,935	5,491	98.48
14	16,928	5,031	85.16
15	13,392	4,555	61.00
16	10,981	4,240	46.56
17	7,790	3,769	29.36
18	5,851	3,141	18.38
19	5,326	3,141	16.73
20+	6,351	3,141	19.95
	508,311		5,458.06

* From Table 3-10.

**From Table 2-2.

TABLE 5-4

HIGH-ALTITUDE REGIONS
LIGHT-DUTY GASOLINE TRUCKS (0-6000 LBS. GVW)
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGT1 + LDDT Estimated Registrations*	Annual Mileage**	VMT by Year ($x10^6$)
1	43,794	15,610	683.62
2	34,329	14,049	482.29
3	40,421	12,488	504.78
4	37,680	11,239	423.49
5	52,429	10,147	532.00
6	55,346	9,366	518.37
7	42,527	8,585	365.09
8	26,606	7,961	211.81
9	25,426	7,493	190.52
10	24,745	7,025	173.83
11	23,448	6,556	153.73
12	17,006	6,244	106.19
13	17,935	5,932	106.39
14	16,928	5,463	92.48
15	13,392	5,151	68.98
16	10,981	4,996	54.86
17	7,790	4,683	36.48
18	5,851	4,370	25.57
19	5,326	4,371	23.28
20+	6,351	4,371	27.76
	508,311		4781.52

*From Table 3-10.

**From Table 2-2.

TABLE 5-5

HIGH-ALTITUDE REGIONS
LIGHT-DUTY GASOLINE TRUCKS (6001-8500 LBS. GVW)
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGT2 Estimated Registrations*	Annual Mileage**	VMT by Year ($x10^6$)
1	74,662	15,800	1,179.66
2	62,199	14,220	884.47
3	47,477	12,640	600.11
4	23,701	11,376	269.62
5	16,986	10,270	174.45
6	18,817	9,480	178.39
7	13,366	8,690	116.15
8	8,952	8,058	72.14
9	8,100	7,584	61.43
10	6,069	7,110	43.15
11	5,235	6,636	34.74
12	3,394	6,320	21.45
13	2,934	6,004	17.62
14	2,421	5,510	13.34
15	1,627	5,234	8.52
16	1,651	5,056	8.35
17	1,350	4,740	6.40
18	860	4,424	3.80
19	777	4,424	3.44
20+	1,192	4,424	5.27
	301,770		3,702.5

*From Table 3-11.

**From Table 2-2.

TABLE 5-6

HIGH-ALTITUDE REGIONS
HEAVY-DUTY GASOLINE VEHICLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	HDGV Estimated Registrations*	Annual Mileage**	VMT by Year ($x10^6$)
1	20,836	20,980	437.14
2	15,048	18,882	284.14
3	13,677	17,204	235.30
4	10,103	15,525	156.85
5	10,555	14,057	148.37
6	10,304	12,587	129.70
7	7,483	11,329	84.77
8	5,288	10,280	54.36
9	4,044	9,441	38.18
10	4,842	8,602	41.65
11	4,198	7,973	33.47
12	3,252	7,343	23.88
13	3,042	6,713	20.42
14	2,465	6,294	15.51
15	1,886	5,875	11.08
16	1,595	5,454	8.70
17	1,128	5,245	5.92
18	746	5,036	3.76
19	622	5,034	3.13
20+	692	5,034	3.48
	121,806		1,739.81

*From Table 3-12.

**From Table 2-2.

TABLE 5-7

HIGH-ALTITUDE REGIONS
HEAVY-DUTY DIESEL VEHICLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	HDDV Estimated Registrations*	Annual Mileage**	VMT by Year ($x10^6$)
1	12,770	70,418	899.24
2	8,835	66,897	591.03
3	8,002	60,560	484.60
4	6,036	54,221	327.28
5	6,656	47,885	318.72
6	6,626	43,659	289.28
7	4,926	39,434	194.25
8	3,579	36,618	131.06
9	2,767	34,504	95.47
10	3,062	33,096	101.34
11	2,269	32,392	73.50
12	1,723	31,689	54.60
13	1,856	30,953	57.45
14	1,415	29,606	41.89
15	948	27,463	26.03
16	695	24,646	17.13
17	513	20,422	10.48
18	280	17,605	4.93
19	277	17,604	4.88
20+	504	17,604	8.87
	73,739		3,732.03

*From Table 3-13.

**From Table 2-2.

TABLE 5-8

HIGH-ALTITUDE REGIONS
MOTORCYCLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	Estimated Registrations*	Annual Mileage**	VMT by Year ($x10^6$)
1	35,119	4,067	142.8
2	37,625	2,845	107.0
3	32,625	2,072	67.5
4	27,574	1,569	43.2
5	28,801	1,180	33.9
6	24,110	777	18.7
7	15,760	630	9.9
8	11,124	387	4.3
9	7,914	243	1.9
10	3,088	162	.5
	223,740		429.7

*From Table 3-14.

**From Table 2-3.

TABLE 5-9

HIGH-ALTITUDE REGIONS
CALCULATION OF AVERAGE MILES PER DAY PER VEHICLE TYPE

Vehicle Type	VMT Per Year ($x10^6$)	VMT Per Day ($x10^6$)	Estimated High-Altitude Registrations	Average Miles Per Day
LDGV	26,731.4	73.24	2,298,667	31.9
LDDV				31.9
LDGT1	4,781.5	13.10	508,311*	25.8
LDGT2	3,702.5	8.21	301,770	33.6
LDDT	5,458.1	14.95	508,311*	29.4
HDGV	1,739.8	4.76	121,806	39.1
HDDV	3,732.0	10.23	73,739	138.7
MC	429.7	2.05	223,740	9.2

*LDGT1 and LDDT registrations combined.

Table 5-10

STATE OF CALIFORNIA
LIGHT-DUTY GASOLINE AND DIESEL VEHICLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGV+LDDV Estimated Registrations*	Annual Mileage (From Table 2-1)	VMT by Year ($\times 10^6$)
1	640,608	14,436	9,247.82
2	1,108,745	13,903	15,414.88
3	1,194,981	13,371	15,978.09
4	1,170,342	12,838	15,024.85
5	1,145,703	12,306	14,099.02
6	1,096,426	11,773	12,908.22
7	1,022,510	11,240	11,493.01
8	936,274	10,708	10,025.62
9	850,038	10,176	8,649.98
10	726,844	9,643	7,008.96
11	603,650	9,110	5,499.25
12	455,818	8,577	3,909.55
13	344,943	8,045	2,775.07
14	246,388	7,513	1,851.11
15	184,791	6,980	1,289.84
16	135,513	6,447	873.65
17	110,875	5,927	657.16
18	73,916	5,382	397.82
19	61,597	4,850	298.74
20+	209,430	4,317	904.11
	12,319,392		138,306.75

* Estimated using the registration fractions in Table 3-3 and the State of California Department of Motor Vehicles estimate of passenger cars registered in 1978.

Table 5-11

STATE OF CALIFORNIA
LIGHT-DUTY GASOLINE TRUCKS (0-6000 LBS. GVW)
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGT1+LDDT Estimated Registrations*	Annual Mileage (From Table 2-2)	VMT by Year ($\times 10^6$)
1	126,976	15,610	1,982.10
2	234,786	14,049	3,298.51
3	234,786	12,448	2,922.62
4	206,037	11,239	2,315.65
5	184,475	10,147	1,871.87
6	167,705	9,366	1,570.72
7	153,330	8,585	1,316.34
8	138,955	7,961	1,106.22
9	126,976	7,493	951.43
10	112,602	7,025	791.03
11	100,623	6,556	659.68
12	86,248	6,224	538.53
13	74,269	5,932	440.56
14	62,290	5,463	340.29
15	55,103	5,151	283.84
16	50,311	4,996	251.35
17	43,124	4,683	201.95
18	38,332	4,370	167.51
19	31,145	4,371	136.13
20+	167,705	4,371	733.04
	2,395,778		21,879.37

* Estimated using the registration fractions in Table 3-3 and the State of California Department of Motor Vehicles estimate of trucks registered in 1978. The CARB report (980) estimated that 2,011,570 LDGT1's were registered in 1975. This number was multiplied by the ratio of total trucks registered in 1978/1975 as reported by the DMV to estimate 1978 LDGT1 + LDDT registrations.

Table 5-12

STATE OF CALIFORNIA
LIGHT-DUTY DIESEL TRUCKS (0-8500 LBS. GVW)
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGT1+LDDT Estimated Registrations*	Annual Mileage (From Table 2-2)	VMT by Year ($\times 10^6$)
1	126,976	15,705	1,994.16
2	234,786	15,077	3,539.87
3	234,786	14,605	3,429.05
4	206,037	13,978	2,879.98
5	184,475	13,035	2,404.63
6	167,705	12,093	2,028.06
7	153,330	10,993	1,685.56
8	138,955	9,738	1,353.14
9	126,976	9,266	1,176.56
10	112,602	7,381	831.12
11	100,623	6,753	679.51
12	86,248	6,125	528.27
13	74,269	5,491	407.81
14	62,290	5,031	313.38
15	55,103	4,555	250.99
16	50,311	4,240	213.32
17	43,124	3,769	162.53
18	38,332	3,141	120.40
19	31,145	3,141	97.83
20+	167,705	3,141	526.76
	2,395,778		24,622.93

* Estimated using the registration fractions in Table 3-3 and the State of California Department of Motor Vehicles estimate of trucks registered in 1978. The CARB report (1980) estimated that 2,011,570 LDGT1's were registered in 1975. This number was multiplied by the ratio of total trucks registered in 1978/1975 as reported by the DMV to estimate 1978 LDGT1 + LDDT registrations.

Table 5-13

STATE OF CALIFORNIA
LIGHT-DUTY GASOLINE TRUCKS (6001-8500 LBS. GVW)
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	LDGT2 Estimated Registrations*	Annual Mileage (From Table 2-1)	VMT by Year ($\times 10^6$)
1	13,197	15,800	208.51
2	24,402	14,220	346.99
3	24,402	12,640	308.44
4	21,414	11,376	243.61
5	19,173	10,270	196.91
6	17,430	9,480	165.24
7	15,936	8,690	138.48
8	14,442	8,058	116.37
9	13,197	7,584	100.09
10	11,703	7,110	83.21
11	10,458	6,636	69.40
12	8,964	6,320	56.65
13	7,719	6,004	46.34
14	6,474	5,510	35.67
15	5,727	5,234	29.98
16	5,229	5,056	26.43
17	4,482	4,740	21.24
18	3,984	4,424	17.63
19	3,237	4,424	14.32
20+	17,430	4,424	77.11
	249,000		2,302.62

* Estimated using the registration fractions in Table 3-3 and the State of California Department of Motor Vehicles estimate of trucks registered in 1978. The CARB report (1980) estimated that 209,064 LDGT2's were registered in 1975. This number was multiplied by the ratio of total trucks registered in 1978/1975 as reported by the DMV to estimate LDGT2 registrations in 1978.

Table 5-14

STATE OF CALIFORNIA
HEAVY-DUTY GASOLINE VEHICLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	HDGV Estimated Registrations*	Annual Mileage (From Table 2-2)	VMT by Year ($\times 10^6$)
1	17,056	20,980	357.83
2	31,731	18,882	599.14
3	32,128	17,204	552.73
4	29,351	15,525	455.67
5	27,368	14,057	384.71
6	25,782	12,587	324.52
7	23,798	11,329	269.61
8	22,212	10,280	228.34
9	20,625	9,441	194.72
10	18,642	8,602	160.36
11	17,056	7,973	135.99
12	15,469	7,343	113.59
13	13,486	6,713	90.53
14	11,899	6,294	74.89
15	11,106	5,875	65.25
16	10,313	5,454	56.25
17	9,519	5,245	49.93
18	8,726	5,036	43.94
19	7,933	5,034	39.93
20+	42,441	5,034	213.65
	396,641		4,411.58

* Estimated using the registration fractions in Table 3-3 and the State of California Department of Motor Vehicles estimate of trucks registered in 1978. The CARB report (1980) estimated that 333,032 HDGV's were registered in 1975. This number was multiplied by the ratio of total trucks registered in 1978/1975 as reported by the DMV to estimate HDGV registrations in 1978.

Table 5-15

STATE OF CALIFORNIA
HEAVY-DUTY DIESEL VEHICLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	HDDV Estimated Registrations*	Annual Mileage (From Table 2-2)	VMT by Year ($\times 10^6$)
1	3,989	70,418	280.89
2	7,978	66,897	533.70
3	8,083	60,560	489.51
4	7,453	54,221	404.11
5	7,033	47,885	336.78
6	6,824	43,659	297.93
7	6,719	39,434	264.96
8	6,404	36,618	234.50
9	5,879	34,504	202.85
10	5,354	33,096	177.20
11	4,724	32,392	153.02
12	4,199	31,689	133.06
13	3,569	30,953	110.47
14	3,149	29,606	93.23
15	2,939	27,463	80.71
16	2,729	24,646	67.26
17	2,624	20,422	53.59
18	2,414	17,604	42.50
19	2,205	17,605	38.82
20+	10,708	17,605	18.85
	104,976		4,013.94

Table 5-16

STATE OF CALIFORNIA
MOTORCYCLES
CALCULATION OF AVERAGE ANNUAL MILES DRIVEN

Model Year Mix	MC Estimated Registrations*	Annual Mileage (From Table 2-3)	VMT by Year ($\times 10^6$)
1	68,875	4,067	280.11
2	91,833	2,845	261.26
3	91,833	2,072	190.28
4	87,241	1,569	136.88
5	80,682	1,180	95.20
6	68,875	777	53.52
7	45,917	630	28.93
8	34,765	387	13.45
9	28,206	243	6.85
10	21,646	162	3.51
11	15,087	162	2.44
12	10,495	162	1.70
13	7,215	162	1.17
14	3,280	162	0.53
15	0		
16	0		
17	0		
18	0		
19	0		
20+	0		
	665,950		1,075.83

* Estimated using the registration fractions in Table 3-3 and the State of California Department of Motor Vehicles estimate of motorcycles registered in 1978.

Table 5-17

STATE OF CALIFORNIA
CALCULATION OF AVERAGE MILES PER DAY BY VEHICLE TYPE

Vehicle Type	VMT per Year ($\times 10^6$)	VMT per Day ($\times 10^6$)	Estimated Registrations	Average Miles Per Day
LDGV	138,306.8	378.9	12,319,392	30.8
LDDV				
LDGT1	21,879.4	59.9	2,395,778*	25.0
LDGT2	2,302.6	6.3	249,000	25.3
LDDT	24,622.9	67.5	2,395,778*	28.2
HDGV	4,411.6	12.1	396,641	30.5
HDDV	4,013.9	11.0	104,976	104.8
MC	1,075.8	2.9**	655,950	4.5

* LDGT1 and LDDT registrations combined.

** Assumes motorcycles can travel 365 days per year in California.

TABLE 5-18

LOW ALTITUDE REGIONS
MILES TRAVELED PER DAY BY VEHICLE TYPE*

Vehicle Type	Miles/Day
LDGV	31.1
LDDV	31.1
LDGT1	26.3
LDGT2	33.8
LDDT	29.8
HDGV	36.7
HDDV	138.1
MC	8.3

*From Section 5 of National MOBILE2 Variable Estimates, 1980.

6. VEHICLE MILES TRAVELED

Table 6-1 presents estimates of vehicle miles traveled per vehicle type for high altitude regions. VMT fractions are calculated based on VMT per day estimates taken from Table 5-9. Similarly, State of California VMT fraction estimates are shown in Table 6-2.

National VMT fractions should be used for low altitude regions. VMT fractions calculated from vehicle miles per day and national registration estimates are shown in Table 6-3.

TABLE 6-1

HIGH-ALTITUDE REGIONS
ESTIMATED VEHICLE MILES TRAVELED PER VEHICLE TYPE

(1978)

Vehicle Type	VMT Per Day ($\times 10^6$) (from Table 5-9)	VMT Fractions
LDGV	73.24	.6550
LDDV	0.20	.0018
LDGT1	13.10	.1172
LDGT2	8.21	.0734
LDDT	0.02	.0002
HDGV	4.76	.0426
HDDV	10.23	.0915
MC	2.05	.0183
	111.81	

Table 6-2

STATE OF CALIFORNIA
VMT FRACTIONS CALCULATED FROM VEHICLE MILES PER DAY
AND REGISTRATION ESTIMATES

Vehicle Type	Vehicle Miles Traveled Per Day ($\times 10^6$) (From Table 5-17)	VMT Fractions
LDGV	378.18	.8028
LDDV	0.72	.0015
LDGT1	59.85	.1270
LDGT2	6.3	.0134
LDDT	0.05	.0001
HDGV	12.1	.0257
HDDV	11.0	.0233
MC	2.9	.0062
	471.1	

TABLE 6-3

LOW ALTITUDE REGIONS
VMT FRACTIONS CALCULATED FROM VEHICLE MILES PER DAY
AND NATIONAL REGISTRATION ESTIMATES

Vehicle Type	(A) Vehicle Miles Per Day (From Table 5-1)	(B) Estimated National Registrations ($\times 10^3$) (From Sec. 3)	(A x B) National VMT Per Day ($\times 10^3$)	VMT Fractions
LDGV	31.1	102,711.8	3,194,337	.7777
LDDV	31.1	227.2	7,066	.0017
LDGT1	26.3	12,832.6	337,497	.0822
LDGT2	33.8	5,677.4	191,896	.0467
LDDT	29.8	41.0	1,222	.0003
HDGV	36.7	4,654.5	170,820	.0416
HDDV	138.1	1,043.8	144,149	.0351
MC	8.3	7,305.0	60,632	.0148
			4,107,619	

7. FRACTION OF VEHICLES WITH AIR CONDITIONING

No regional data were found for estimating the fraction of vehicles equipped with air conditioning categorized by model year. Therefore, national estimates should be used for both the State of California and high altitude regions. These national estimates are shown in Tables 7-1 and 7-2 for light-duty vehicles and light-duty trucks, respectively.

TABLE 7-1

PERCENTAGE OF LIGHT-DUTY VEHICLES WITH FACTORY INSTALLED AIR CONDITIONING BY MODEL YEAR

NATIONAL AVERAGES

Model Year	U.S. Cars* % with AC	U.S. Cars** % of LDV Sales	Imports* % with AC	Imports** % of LDV Sales	Total+ Fleet % with AC
1978	80.8%	83%	30.7%	17%	72%
1977	81.7	81	27.1	19	71
1976	74.0	85	21.3	15	66
1975	72.6	82	19.3	18	63
1974	67.9	84		16	57
1973	72.6	85		15	62
1972	67.5	85		15	57
1971	63.4	85		15	54
1970	60.1	85		15	51
1969	55.3	89		11	49
1968	44.3	89		11	39
1967	38.0	91		9	35
1966	29.3	93		7	27
1965	23.3	94		6	22
1964	17.9	94		6	17
1963	14.1	95		5	13
1962	11.3	95		5	11
1961	8.1	94		6	8
1960	6.9	93		7	6
1959	6.2	90		10	6

* Source: Ward's Automotive Yearbook

** Source: McNutt, Dulla, and Lax, 1979

+ Data on the percentage of imports with AC for pre-1975 model years was not reported in Ward's Automotive Yearbook. The total fleet AC percentage for pre-1975 LDV's was calculated assuming no imports with AC.

TABLE 7-2

LIGHT-DUTY TRUCKS WITH FACTORY INSTALLED AIR CONDITIONING
BY MODEL YEAR

NATIONAL AVERAGES

Model Year	U.S. Light Trucks* % with AC	U.S. LDT's** % of Sales	Imports* % with AC	Imports** % of Sales	Total Fleet % with AC
1978	41.2%	93.4%	12.5%	6.6%	39%
1977	53.2	96.4	10.5	3.6	52
1976	33.3	94.1	2.1	5.9	32
1975	30.6	88.5		11.5	27
1974	29.3	91.6		8.4	27
1973		97.3		2.7	
1972		92.5		7.5	
1971		94.6		5.4	
1970		95.2		4.8	

---

* Source: Ward's Automotive Yearbook

** Source: McNutt, Dulla, and Lax, 1979

8. AMBIENT CONDITIONS

Table 8-1 gives monthly mean temperatures (dry bulb) for the 48 contiguous United States based on ten years of observations. The corresponding monthly mean relative humidities have been further averaged over all hours of the day for purposes of this presentation. The humidity factor H (given in grains of water vapor per pound of dry air) was computed using the methodology in Section 4.2 of Techniques for Estimating MOBILE2 Variables and is reported to the nearest whole number. The mean dry bulb temperature and relative humidity were used to infer corresponding wet bulb temperatures using standard psychrometric tables. No correction for ambient pressure variation was made, but given the lack of sensitivity and resolution in a nationwide scale analysis of temperature, such a correction would be superfluous.

The values in Table 8-1 can be used to estimate the frequency of air conditioning usage in light-duty vehicles and light-duty trucks. Average monthly dry and wet bulb temperatures can be used in the discomfort index (DI) equation presented in Section 13 of the Techniques report to estimate the percentage of air conditioners in use nationwide for each month. We strongly recommend that values specific to local means (e.g., see the local climatological data (LCD's) given in Section 4 of the Task 1 report) for the time period of analysis be used in the DI equation whenever possible. However, as mentioned above, pressure corrections need not be considered in a nationwide scale analysis. Such corrections, e.g., for ambient pressures in a high altitude area like Denver, would result in a wet bulb temperature decrease of only 2 or 3^{o}F for the range of national means given in Table 8-1. The discomfort index (Equation 13-1 of Task 4 draft report) is relatively insensitive to such a change.

Tables 8-2 through 8-4 present the same information that Table 8-1 presents for the entire United States, for three specific urban areas: Denver, San Francisco, and Los Angeles. It should be noted that the numbers in these tables are averages. Therefore, they do not represent the maximum temperatures that may occur during a day. Thus, it is again recommended that temperature and humidity values for the "time period of analysis" be used in the DI equation whenever possible.

TABLE 8-1

AMBIENT CONDITIONS LIKELY TO AFFECT VEHICLE AIR CONDITIONING USAGE

WET BULB TEMPERATURES CORRESPONDING TO MONTHLY
MEAN DRY BULB TEMPERATURES AND MEAN RELATIVE HUMIDITIES
FOR THE UNITED STATES

	Mean Dry Bulb (°F)*	Mean Relative Humidity (%)*	H(grains of water vapor/pound of dry air)**	Mean Wet Bulb (°F)†	Discomfort Index	AC Usage
January	45	67	31	40	49	0
February	49	64	36	43	52	0
March	55	65	41	49	57	0
April	65	69	63	59	65	0
May	72	72	91	66	70	0
June	81	67	112	73	77	70%
July	85	62	121	75	79	90%
August	85	62	121	75	79	90%
September	78	71	99	71	75	50%
October	68	68	71	61	67	0
November	56	67	44	50	62	0
December	48	68	33	43	51	0

* Source: Climatography of the United States Series 82

** To the nearest whole number

† Source: Handbook of Chemistry and Physics

TABLE 8-2

AMBIENT CONDITIONS LIKELY TO AFFECT VEHICLE AIR CONDITIONING USAGE

WET BULB TEMPERATURES CORRESPONDING TO MONTHLY
MEAN DRY BULB TEMPERATURES AND MEAN RELATIVE HUMIDITIES
FOR DENVER, COLORADO

	Mean Dry Bulb (°F)*	Mean Relative Humidity (%)*	H(grains of water vapor/pound of dry air)**	Mean Wet Bulb (°F)†	Discomfort Index	AC Usage
January	30	55	16	26	37	0
February	33	54	19	28	39	0
March	37	53	21	32	43	0
April	48	50	30	41	51	0
May	57	52	44	49	57	0
June	66	51	60	56	64	0
July	73	49	74	61	69	0
August	72	49	70	60	68	0
September	63	50	52	53	61	0
October	52	49	34	44	53	0
November	39	58	25	34	44	0
December	33	56	19	29	40	0

Source: Local Climatological Data for Stapleton International Airport, Denver, Colorado. NOAA, Environmental Data and Information Service, Asheville, NC. (1941-1970).

TABLE 8-3

AMBIENT CONDITIONS LIKELY TO AFFECT VEHICLE AIR CONDITIONING USAGE

WET BULB TEMPERATURES CORRESPONDING TO MONTHLY
MEAN DRY BULB TEMPERATURES AND MEAN RELATIVE HUMIDITIES
FOR SAN FRANCISCO, CALIFORNIA

	Mean Dry Bulb (°F)*	Mean Relative Humidity (%)*	H(grains of water vapor/pound of dry air)**	Mean Wet Bulb (°F)†	Discomfort Index	AC Usage
January	48	78	40	45	52	0
February	51	76	45	48	55	0
March	53	73	46	49	56	0
April	55	71	48	51	57	0
May	58	72	52	53	59	0
June	62	72	63	57	63	0
July	63	74	65	58	63	0
August	63	75	66	58	63	0
September	64	71	66	59	64	0
October	61	71	58	56	62	0
November	55	75	50	51	57	0
December	50	78	42	47	54	0

Source: Local Climatological Data for San Francisco International Airport, San Francisco, California. NOAA, Environmental Data and Information Service, Asheville, NC. (1941-1970)

TABLE 8-4

AMBIENT CONDITIONS LIKELY TO AFFECT VEHICLE AIR CONDITIONING USAGE

WET BULB TEMPERATURES CORRESPONDING TO MONTHLY
MEAN DRY BULB TEMPERATURES AND MEAN RELATIVE HUMIDITIES
FOR LOS ANGELES, CALIFORNIA

	Mean Dry Bulb (°F)*	Mean Relative Humidity (%)*	H(grains of water vapor/pound of dry air)**	Mean Wet Bulb (°F)†	Discomfort Index	AC Usage
January	56	56	38	48	57	0
February	57	60	40	50	58	0
March	59	61	46	52	59	0
April	62	64	56	55	62	0
May	65	66	61	59	65	0
June	68	68	71	61	67	0
July	73	66	80	65	70	0
August	73	67	81	65	70	0
September	72	64	74	64	69	0
October	67	63	63	59	65	0
November	63	53	46	54	62	0
December	58	54	39	50	58	0

Source: Local Climatological Data for the Los Angeles Civic Center, Los Angeles, California, NOAA, Environmental Data and Information Services, Asheville, NC (1931-1960)

9. VMT PERCENTAGE IN HOT/COLD STARTS

The State of California Air Resources Board estimates the fraction of vehicle miles traveled in hot/cold starts using the following equations:

$$F_{cold} = 0.343 + 0.187\ Nc \qquad (9\text{-}1)$$

$$F_{hot} = 0.470 + 0.187\ (1\text{-}Nc) \qquad (9\text{-}2)$$

where:

Nc = fraction of vehicle miles traveled by vehicles equipped with a catalytic converter

Equations (9-1) and (9-2) were calibrated with data collected from a study in Sacramento. CARB's calculations of these fractions for 1975-1990 are shown in Table 9-1.

Similar estimates for high-altitude areas are not available. Therefore, national estimates are recommended for use. The national estimates are shown in Table 9-2.

TABLE 9-1

STATE OF CALIFORNIA
COLD AND HOT START VMT PERCENTAGES
BY VEHICLE TYPE AND CALENDAR YEAR

Vehicle Type	1975	1978	1979	1980	1981	1984	1986	1987	1990
Light Duty Vehicles									
Fraction cold start	.529	.529	.451	.468	.482	.511	.517	.523	.527
Fraction hot start	.471	.471	.549	.532	.518	.489	.483	.477	.473
Light Duty Trucks I									
Fraction cold start	.525	.525	.436	.452	.466	.495	.502	.511	.519
Fraction hot start	.475	.475	.564	.548	.534	.505	.498	.489	.481
Light Duty Trucks II									
Fraction cold start	.524	.524	.395	.419	.439	.478	.487	.501	.514
Fraction hot start	.476	.476	.605	.581	.561	.522	.513	.499	.486
Heavy Duty Gas									
Fraction cold start	.000	.000	.000	.000	.000	.000	.000	.000	.000
Fraction hot start	.000	.000	.000	.000	.000	.000	.000	.000	.000
Heavy Duty Diesel									
Fraction cold start	.000	.000	.000	.000	.000	.000	.000	.000	.000
Fraction hot start	.000	.000	.000	.000	.000	.000	.000	.000	.000
Motorcycles									
Fraction cold start	.343	.343	.343	.343	.343	.343	.343	.343	.343
Fraction hot start	.657	.657	.657	.657	.657	.657	.657	.657	.657

SOURCE: California Air Resources Board, 1980.

TABLE 9-2

PERCENTAGE OF VMT IN COLD AND HOT START MODES
NATIONAL AVERAGES

Hour Begin.	ATL = 10 Min.		ATL = 15 Min.		ATL = 20 Min.		ATL = 25 Min.	
	Non-Catalytic	Catalytic	Non-Catalytic	Catalytic	Non-Catalytic	Catalytic	Non-Catalytic	Catalytic
	Cold	Cold Hot	Cold	Cold Hot	Cold	Cold Hot	Cold	Cold Hot
AM 1	47.5	58.0 10.0	28.7	36.4 7.0	15.6	24.2 3.7	8.2	17.5 3.7
2	49.6	57.6 10.0	29.8	35.4 7.0	17.4	21.9 6.0	16.0	18.8 6.0
3	57.3	61.1 8.5	27.3	29.5 8.0	18.7	21.0 7.2	16.2	19.5 6.7
4	59.5	61.7 7.0	33.3	34.8 7.0	19.6	21.0 7.0	17.0	18.0 7.0
5	63.7	65.6 7.0	31.5	31.7 7.0	20.0	20.0 7.0	18.0	18.0 7.0
6	61.2	62.0 8.0	32.1	32.8 8.0	20.0	20.2 8.0	17.0	17.0 8.0
7	56.3	59.7 10.0	29.6	31.9 10.0	18.0	18.3 10.0	16.2	16.2 10.0
8	45.5	51.8 22.0	22.7	27.3 17.4	14.2	15.2 13.5	13.6	14.4 10.0
9	34.2	47.4 29.0	17.0	24.1 19.5	9.3	13.1 14.3	8.3	11.2 12.0
10	27.7	41.0 36.1	14.3	24.2 23.7	7.1	13.3 16.0	5.6	10.0 13.0
11	17.6	37.0 36.8	10.0	22.6 23.8	5.7	13.2 16.1	4.6	10.0 12.3
12	18.8	35.3 37.7	10.8	21.5 24.5	6.0	13.3 15.2	5.0	10.0 12.5
PM 1	18.6	39.4 38.8	11.2	24.6 22.7	5.8	12.8 14.0	4.8	10.0 13.0
2	22.2	39.3 31.4	13.6	24.5 22.0	6.2	12.3 16.0	4.7	10.4 12.0
3	29.2	42.3 26.7	17.9	25.2 19.4	10.4	14.3 14.4	6.8	12.0 12.0
4	29.0	41.3 29.4	17.2	24.7 19.6	11.3	16.5 21.0	10.0	14.0 9.7
5	28.3	41.7 28.7	16.9	24.7 19.0	11.9	16.3 11.4	10.2	13.8 8.4
6	19.5	40.1 31.8	12.1	24.9 21.0	8.0	14.2 14.6	5.0	12.0 11.3
7	17.3	42.8 31.0	10.7	26.2 21.0	5.0	14.0 14.6	3.0	11.0 12.0
8	14.0	45.0 28.4	9.5	27.5 19.7	3.5	13.7 14.6	2.0	10.5 12.4
9	15.8	47.6 27.6	10.5	30.7 15.2	3.7	17.6 10.0	2.7	13.2 10.0
10	30.4	53.0 17.0	19.5	32.7 11.1	7.5	19.4 8.3	4.6	15.0 7.0
11	43.0	57.7 14.1	24.6	33.5 9.7	11.3	19.3 7.9	7.5	16.0 8.0
MIDN	44.7	56.2 13.0	27.3	35.0 10.2	15.0	20.0 7.6	11.8	17.5 5.0

ATL = Average trip length of all internal auto driver trips.

Source: Ellis, Camps and Treadway, 1978.

10. EXTRA LOAD AND TRAILER TOWING TRIPS

Due to the lack of region-specific data necessary to estimate the percentage of vehicles with extra loads or towing trailers, it is recommended that national estimates be used. As calculated in the National MOBILE2 Variable Estimates (1980) report, approximately 11.2 percent of all trips by light-duty vehicles involve carrying a heavy load. No estimates of the percentage of light-duty truck trips with extra loads are available at this time.

The national estimate of the percentage of light-duty vehicle trips towing trailers is 0.0032 percent. For light-duty trucks, the national estimate for the percentage of trips with trailers is 0.0054 percent.

11. SPEED BY ROAD TYPE

There is very little region-specific data available on average vehicle speeds. Therefore, the national average speeds presented in Section 11 of the report for Task Order No. 5 of this contract are recommended for use in estimating vehicle speeds in California or high-altitude areas. Regional speeds needed for air quality modeling are not likely to vary significantly from national averages. One reason for this is the Federally mandated speed limit of 55 mph. Another is that most air quality analyses are conducted in urban areas in which a large proportion of driving occurs on urban freeways and arterials during peak commuter hours. For these reasons, average urban speeds in California and high-altitude areas should not differ significantly from national average urban speeds.

Table 11-1 illustrates state-by-state differences in free-flow speeds. This table is from FHWA's Highway Statistics 1978 publication. It shows the small differences in vehicle speeds which exist between States.

FREE FLOW SPEED DATA -- OCTOBER 1977 - SEPTEMBER 1978

HIGHWAY STATISTICS DIVISION
OFFICE OF HIGHWAY PLANNING, FHWA.

(BASED ON STATE CERTIFICATION REPORTS FOR FISCAL YEAR 1978)

TABLE FE-1
OCTOBER 1977

REGION AND STATE	INTERSTATE URBAN						INTERSTATE RURAL						MULTI-LANE DIVIDED						MULTI-LANE UNDIVIDED						2-LANE RURAL					
	AVER. SPEED	MEDIAN SPEED 1/	85TH PERCENT SPEED 2/	PERCENT EXCEEDING 55 MPH	60 MPH	65 MPH	AVER. SPEED	MEDIAN SPEED 1/	85TH PERCENT SPEED 2/	PERCENT EXCEEDING 55 MPH	60 MPH	65 MPH	AVER. SPEED	MEDIAN SPEED 1/	85TH PERCENT SPEED 2/	PERCENT EXCEEDING 55 MPH	60 MPH	65 MPH	AVER. SPEED	MEDIAN SPEED 1/	85TH PERCENT SPEED 2/	PERCENT EXCEEDING 55 MPH	60 MPH	65 MPH	AVER. SPEED	MEDIAN SPEED 1/	85TH PERCENT SPEED 2/	PERCENT EXCEEDING 55 MPH	60 MPH	65 MPH
1 CONNECTICUT	57.8	57.0	62.3	67	28	7	59.2	58.6	63.8	75	38	11	57.9	57.1	62.5	66	28	6	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
MAINE	55.7	55.1	60.9	51	18	4	59.2	58.6	63.7	77	39	10	58.2	57.5	63.4	68	33	9	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
MASSACHUSETTS	55.8	55.8	60.6	52	18	3	56.6	56.4	60.9	58	24	5	55.7	55.8	61.0	50	18	4	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
NEW HAMPSHIRE	55.0	54.1	59.6	43	17	2	58.4	57.3	62.7	67	36	8	57.7	56.5	61.7	62	30	5	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
NEW JERSEY	55.6	55.1	59.6	51	13	2	56.0	55.5	59.8	56	19	2	56.8	56.4	59.2	45	13	2	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
NEW YORK	58.2	58.2	62.9	73	35	9	58.7	58.6	63.6	77	39	10	55.0	55.3	60.5	53	18	4	51.6	52.9	57.6	30	8	1	53.3	52.1	57.6	28	10	2
RHODE ISLAND	57.4	58.2	62.9	65	28	8	57.9	58.7	63.0	70	31	9	55.1	55.7	60.8	48	17	5	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
VERMONT	3/	3/	3/	3/	3/	3/	58.4	58.3	63.6	73	33	9	3/	3/	3/	3/	3/	3/	52.3	51.1	59.3	34	12	5	3/	3/	3/	3/	3/	3/
PUERTO RICO	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/													53.0	53.1	58.7	39	12	3
3 DELAWARE	58.3	58.2	62.8	72	37	11	3/	3/	3/	3/	3/	3/	56.3	56.4	62.8	60	24	6	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
MARYLAND	56.0	56.0	61.0	55	16	2	57.5	58.0	62.0	67	25	4	56.7	57.0	61.0	60	21	3	54.9	55.0	60.0	45	11	1	52.7	53.0	57.0	27	5	1
PENNSYLVANIA	58.7	58.2	62.9	78	36	10	59.3	58.8	62.9	83	41	10	56.5	56.0	61.1	61	23	6	53.9	53.6	58.5	41	11	3	54.1	53.6	59.0	44	14	4
VIRGINIA	57.2	57.0	62.0	65	22	5	58.9	59.0	64.0	76	36	10	55.0	55.0	61.0	49	16	3	53.4	54.0	59.0	36	9	2	51.1	51.0	57.0	28	11	2
WEST VIRGINIA	56.3	56.3	60.8	61	20	3	58.2	58.2	62.7	74	33	7	57.0	56.8	61.3	66	24	5	3/	3/	3/	3/	3/	3/	54.2	55.0	59.4	45	12	2
DIST. OF COL.	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/
4 ALABAMA	56.9	57.0	62.4	65	27	7	59.9	59.6	65.5	82	45	17	56.1	56.1	61.8	59	24	6	3/	3/	3/	3/	3/	3/	56.0	56.3	61.0	46	18	6
FLORIDA	55.8	55.9	62.1	54	20	4	58.9	59.8	64.4	75	37	10	56.3	56.5	62.3	57	23	6	3/	3/	3/	3/	3/	3/	55.6	55.5	62.4	51	22	7
GEORGIA	60.2	59.3	63.6	77	42	6	62.2	61.2	66.3	85	59	15	58.6	57.6	63.4	61	33	7	3/	3/	3/	3/	3/	3/	56.9	55.9	61.8	49	23	6
KENTUCKY	56.9	56.8	62.1	62	24	5	61.1	63.4	67.0	85	51	20	56.9	56.9	63.0	59	28	8	3/	3/	3/	3/	3/	3/	51.7	51.9	58.2	30	10	3
MISSISSIPPI	57.0	56.0	61.9	58	25	7	61.6	63.5	66.2	84	54	20	59.3	58.5	63.4	75	38	10	3/	3/	3/	3/	3/	3/	55.6	55.0	61.8	51	25	8
NORTH CAROLINA	57.5	57.0	61.0	69	20	4	59.0	58.0	63.0	81	32	7	56.8	56.0	61.0	63	19	3	3/	3/	3/	3/	3/	3/	53.7	54.0	59.0	39	10	2
SOUTH CAROLINA	58.6	58.2	62.2	78	32	5	59.9	59.4	63.5	86	46	8	56.5	56.4	60.7	62	19	3	3/	3/	3/	3/	3/	3/	55.6	55.4	59.7	55	13	2
TENNESSEE	52.9	54.9	60.2	41	9	3	59.0	60.4	67.7	78	60	20	53.4	55.2	60.9	43	10	4	52.8	54.2	62.2	39	15	9	52.8	54.4	63.0	41	17	9
5 ILLINOIS	58.5	58.3	64.1	66	31	9	59.2	58.6	63.5	78	36	9	57.5	56.9	62.5	63	26	7	55.9	55.2	61.5	52	20	5	55.3	54.8	61.0	48	18	5
INDIANA	58.3	57.7	62.5	74	31	7	60.0	59.3	64.5	84	43	13	57.4	57.0	62.1	65	26	6	3/	3/	3/	3/	3/	3/	56.2	55.7	61.3	55	21	6
MICHIGAN	56.4	56.0	61.5	57	21	5	57.8	58.0	62.6	69	27	6	57.6	58.0	61.5	68	27	5	52.6	53.0	57.5	33	8	1	54.7	55.0	59.5	46	15	3
MINNESOTA	56.4	55.8	60.0	59	15	2	58.3	57.6	61.8	76	27	5	56.5	56.1	60.3	60	17	3	3/	3/	3/	3/	3/	3/	56.5	55.9	60.7	58	18	4
OHIO	58.3	58.5	63.0	75	36	9	58.3	58.3	63.1	75	36	9	56.6	56.5	61.3	63	23	5	3/	3/	3/	3/	3/	3/	54.9	54.7	60.7	48	19	5
WISCONSIN	58.5	58.5	63.2	85	35	5	58.1	58.1	62.8	79	31	5	57.2	57.2	62.1	72	25	4	3/	3/	3/	3/	3/	3/	55.0	55.1	60.5	52	16	3
6 ARKANSAS	56.5	56.7	61.7	56	25	3	60.2	60.3	65.6	81	52	12	57.6	57.9	63.5	66	34	7	3/	3/	3/	3/	3/	3/	53.5	54.3	61.0	40	19	6
LOUISIANA	55.5	54.3	60.1	46	12	3	56.9	55.8	61.0	52	17	6	55.7	56.1	60.0	55	12	4	3/	3/	3/	3/	3/	3/	52.2	51.3	57.4	28	8	2
NEW MEXICO	55.3	54.8	62.6	47	18	6	59.3	59.9	68.3	73	42	16	56.2	57.1	61.8	57	23	6	3/	3/	3/	3/	3/	3/	57.8	59.0	65.9	66	34	14
OKLAHOMA	58.8	59.0	64.0	76	37	10	60.3	60.0	66.0	82	47	17	57.6	58.0	63.0	66	30	8	58.7	58.0	65.0	71	36	12	56.6	57.0	62.0	59	25	7
TEXAS	59.6	60.4	65.9	78	39	14	61.1	61.8	68.6	85	48	23	60.6	61.5	67.3	82	47	20	58.5	60.0	65.1	71	34	13	59.2	60.0	67.5	74	38	20
7 IOWA	55.8	56.2	60.6	53	13	1	58.3	58.7	63.3	75	30	6	57.6	57.9	62.2	70	23	4	3/	3/	3/	3/	3/	3/	55.9	56.5	61.2	55	16	3
KANSAS	57.3	57.6	61.9	68	22	3	58.8	58.5	63.0	77	31	8	57.7	57.7	62.3	70	26	6	3/	3/	3/	3/	3/	3/	58.5	58.1	63.3	73	34	11
MISSOURI	57.1	57.0	60.0	68	15	2	59.8	60.0	64.0	84	42	10	58.6	58.0	63.0	74	30	7	3/	3/	3/	3/	3/	3/	57.1	57.0	62.0	63	20	6
NEBRASKA	55.8	55.1	60.3	51	16	3	59.2	58.5	63.3	80	36	9	53.8	53.8	58.6	39	9	2	3/	3/	3/	3/	3/	3/	55.4	55.2	59.8	52	16	2
8 COLORADO	55.6	55.0	60.0	50	13	2	56.5	57.0	61.0	60	18	3	53.9	54.0	59.0	38	9	1	3/	3/	3/	3/	3/	3/	53.4	54.0	59.0	36	8	1
MONTANA	55.7	55.6	61.3	51	17	4	58.8	58.5	64.5	73	34	12	55.6	55.6	61.2	48	16	5	55.3	55.4	60.3	48	14	3	57.5	57.6	63.8	63	29	11
NORTH DAKOTA	54.4	54.5	59.8	51	17	4	58.4	58.3	63.3	75	35	11	56.7	56.8	61.7	64	24	6	3/	3/	3/	3/	3/	3/	56.7	56.7	63.0	61	29	11
SOUTH DAKOTA	53.3	52.2	58.3	30	10	3	57.2	56.0	61.5	57	24	7	59.7	59.1	63.8	78	42	11	3/	3/	3/	3/	3/	3/	56.2	55.4	61.3	54	21	7
UTAH	57.3	57.3	61.6	70	30	6	59.0	59.0	64.5	78	42	15	55.6	56.0	60.0	59	17	3	3/	3/	3/	3/	3/	3/	55.7	55.8	61.6	56	24	8
WYOMING	3/	3/	3/	3/	3/	3/	59.6	59.5	65.2	80	39	16	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	58.3	58.4	64.8	71	33	14
9 ARIZONA	55.7	55.9	60.0	55	15	3	60.6	59.8	65.8	81	48	18	59.1	58.8	64.3	75	39	13	3/	3/	3/	3/	3/	3/	57.6	57.2	63.7	63	32	12
CALIFORNIA	57.9	57.9	62.5	72	34	8	60.0	59.9	66.8	86	48	16	57.7	57.7	62.7	71	33	9	3/	3/	3/	3/	3/	3/	55.8	55.6	61.6	55	25	9
HAWAII	54.1	53.9	59.6	39	18	3	56.3	56.1	62.4	56	22	6	52.6	52.3	58.8	32	12	4	3/	3/	3/	3/	3/	3/	55.0	54.8	61.3	54	23	8
NEVADA	54.8	55.0	60.0	45	15	4	59.4	59.0	65.0	75	41	14	56.7	57.0	63.0	59	26	7	3/	3/	3/	3/	3/	3/	52.0	51.8	58.5	30	11	4
10 ALASKA	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	3/	54.5	54.0	58.1	34	6	1	3/	3/	3/	3/	3/	3/	53.2	52.7	58.8	40	15	4
IDAHO	55.0	54.1	59.3	43	8	2	57.7	56.5	62.5	62	22	8	55.6	54.7	60.2	48	12	4	50.9	50.1	55.5	17	2	1	55.0	54.0	59.5	42	10	4
OREGON	57.5	57.5	61.2	67	26	5	56.7	55.6	60.6	61	17	3	55.6	55.8	59.8	52	15	3	3/	3/	3/	3/	3/	3/	56.2	56.3	60.5	39	12	3
WASHINGTON	56.4	56.6	59.0	60	13	1	57.5	57.5	60.0	67	21	4	56.5	56.6	60.0	59	16	2	3/	3/	3/	3/	3/	3/	56.2	56.3	60.0	56	17	3
NATIONAL AVERAGE	56.7	56.5	61.4	60	23	5	58.8	58.6	63.7	74	36	10	56.5	56.4	61.5	59	23	6	54.6	54.7	60.2	44	15	5	54.9	54.8	60.6	48	18	6

1/ MEDIAN SPEED IS THE SPEED AT OR BELOW WHICH 50 PERCENT OF THE VEHICLES ARE TRAVELING.
2/ 85 TH PERCENTILE SPEED IS THE SPEED AT OR BELOW WHICH 85 PERCENT OF THE VEHICLES ARE TRAVELING.
3/ NO MILEAGE IN THIS HIGHWAY CATEGORY WHERE THE 55 MPH SPEED LIMIT IS THE PRIMARY CONSTRAINT ON VEHICLE SPEEDS.
4/ LOW MILEAGE OF MULTI-LANE UNDIVIDED ROADS COMBINED WITH MULTI-LANE DIVIDED ROADS.
5/ MILEAGE REPORTED BUT NO SPEED DATA SUBMITTED.
6/ WILSON BRIDGE ONLY SECTION WITH 55 MPH SPEED LIMIT. MARYLAND MONITORS NEAR BRIDGE.

TABLE FE-1

REFERENCES

Jambekar, A. and Johnson, J. 1977. The Development of Emission and Fuel Economy Computer Model for Heavy-Duty Trucks and Buses. Michigan Technological University. Houghton, MI.

McNutt, B., Dulla, R. and Lax, D. February 1979. "Factors Influencing Automotive Fuel Demand," SAE Technical Paper Series No. 790226. Congress and Exposition. Detroit, MI.

Motorcycle Industry Council, Inc. 1979. Motorcycle Statistical Annual. Newport Beach, CA.

Murrell, J. D., Foster, J. A. and Bristor, D.M. June 1980. "Passenger Car and Light Truck Fuel Economy Trends through 1980." SAE Technical Paper Series. Paper No. 800853. Dearborn, MI.

State of California Air Resources Board. January 1980. Procedure and Basis for Estimating On-Road Motor Vehicle Emissions. Sacramento, CA.

The Gallup Organization, Inc. January 1975. Survey of Motorcycle Ownership, Usage, and Maintenance. Conducted for the Motorcycle Industry Council, Inc. Newport Beach, CA.

U.S. Department of Commerce. 1972. Truck Inventory and Use Survey, Census of Transportation. Bureau of the Census. Washington, D.C.

U.S. Department of Transportation. 1978. Highway Statistics. Federal Highway Administration. Washington, D.C.

U.S. Environmental Protection Agency. October 1979. Summary and Analysis of Comments on the Notice of Proposed Rulemaking for the Control of Light-Duty Diesel Particulate Emissions from 1981 and Later Model Year Vehicles. Office of Mobile Source Air Pollution Control. Ann Arbor, MI.